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VOLUME CONTROL SYSTEM

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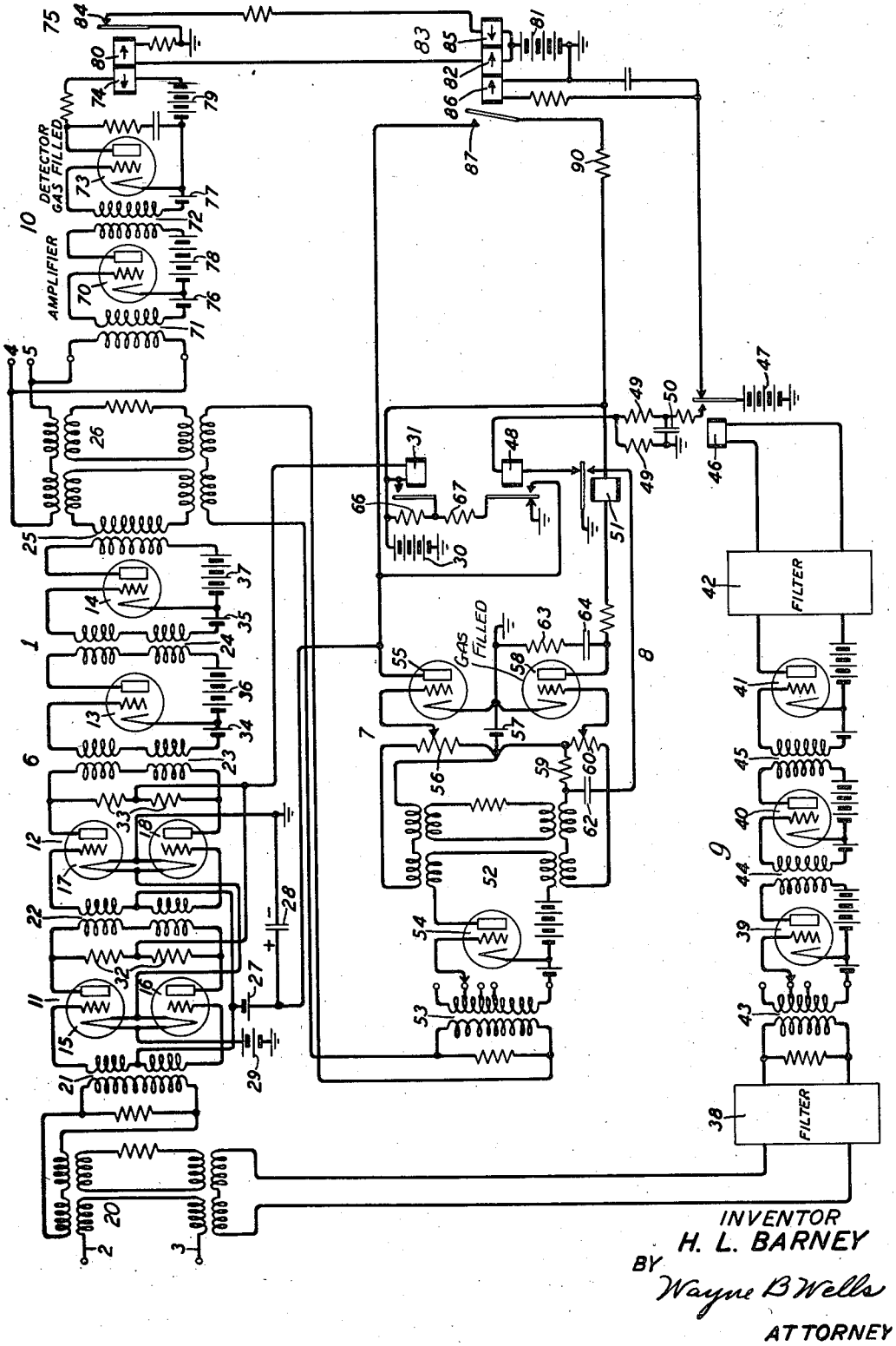

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VOLUME CONTROL SYSTEM

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11 Claims. (Cl. 178—44)

This invention relates to volume control circuits and particularly to voice operated gain control circuits.

One object of the invention is to provide voice operated gain control circuits connected to a transmission line that shall effect an acceleration in the operation of the gain control circuits to raise the volume level in case the volume of the signals received for transmission over the line is suddenly reduced.

Another object of the invention is to provide voice operated gain control circuits connected to a transmission line for holding the signals on the line at constant volume that shall quickly reduce the volume of received signals above normal volume and operate with a time constant in raising the volume of signals reduced below normal volume and that shall accelerate the volume increasing action of the circuits in case the volume of the received signals is suddenly reduced.

A further object of the invention is to provide voice operated gain control circuits connected to a transmission line that shall quickly lower the volume of received signals having a volume above normal and operate with a time constant to raise the volume of signals reduced below normal and that shall automatically accelerate the volume increasing action of the circuits in case the volume of the received signals is suddenly reduced.

In some voice operated gain control circuits serving to maintain constant volume on a transmission line a time constant is used in raising the volume of received signals which are below normal value in order to retain the characteristic variations of intensity from syllable to syllable. When the received signals have a volume above normal value the received signals are quickly reduced by the gain control circuits without any appreciable time delay.

When an operator connects a toll line to a transmission line having voice operated gain control circuits connected thereto the gain control circuits are first set to produce very low gain because of the operator's high volume speech. The speech of a subscriber on a toll line is generally much weaker than the speech of the operator. Accordingly, when the subscriber is connected to the transmission line the gain control circuits are set to produce a low gain in place of high gain as is required to raise the volume of the subscriber's speech. By reason of the time delay of the gain control circuits during raising of the gain, trouble may be caused in getting the call from the subscriber started over the transmission line.

In accordance with the present invention means are provided to accelerate the gain increasing action of the gain control circuits whenever the signal input volume to the transmission line is suddenly decreased a large amount.

The invention is described by means of a voice operated gain control system of the type disclosed in the patent to J. L. Hogg and S. Doba, No. 1,853,974, dated April 12, 1932, and in the application of S. Doba, Serial No. 608,362, filed April 30, 1932.

The gain control circuit comprises a variable repeater in a transmission line which is controlled to maintain constant volume signals on the line beyond the variable repeater. The variable repeater comprises two loss devices and amplifying means. Each loss device comprises two three-element space discharge devices connected effectively in series with the transmission line. The gain effected by the variable repeater is controlled by governing the potential impressed on the grids of the loss devices according to the charge on a control condenser. A gain increaser circuit is provided for increasing the charge on the control condenser to raise the gain effected by the variable repeater. A gain decrease circuit is provided for reducing the charge on the control condenser to lower the gain effected by the variable repeater. A gain increase disabler circuit is operated at the same time as the gain decreaser circuit to prevent operation of the gain increaser circuit.

The gain increaser circuit is connected to the transmission line ahead of the variable repeater and operates a gain increaser relay and a master gain relay whenever the peaks of speech on the line ahead of the variable repeater are above the peaks of the lowest talker. The gain increaser relay operates the master gain relay and causes it to remain operated for a short period by means of capacity and resistance elements. The master gain relay completes a circuit from a battery through resistance elements to charge the control condenser. In order to insure the raising of the gain at a fairly uniform rate a gain rate relay controlled in accordance with the plate current of the loss devices is provided for short-circuiting one of the resistance elements in the charging circuits for the control condenser.

The gain decreaser circuit is controlled from the transmission line at a point beyond the variable repeater and is operated when the peaks of speech on the transmission line beyond the variable repeater are above a predetermined upper limit. The gain decreaser circuit includes

a detector tube which normally has a blocking negative potential impressed upon a grid thereof. This blocking negative potential is reduced when the gain decreaser circuit is operated to complete a grounded circuit through the tube for reducing the charge on the control condenser. The gain increase disabler circuit which is operated at the same time as the gain decreaser circuit operates a gain increase disabler relay to break the circuit of the master gain relay and prevent any increase in the charge on the control condenser by the gain increaser circuit.

In gain control circuits of the type above set forth a time delay is provided by operation of the gain increase disabler circuit to prevent any increase of the gain of the variable repeater by the gain increaser circuit under certain conditions. This time delay is objectionable when a subscriber is first connected to a transmission line and may cause trouble in putting the call through. In order to prevent this time delay when a subscriber is first connected to the transmission line a quick gain increaser circuit is connected to the transmission line beyond the variable repeater to immediately place a resistance other than that normally connected by operation of the master gain relay in the control condenser charging circuit and thus accelerate the raising of the gain. Relay means are provided in the quick gain increaser circuit for insuring operation of said circuit only when the volume of the signals is suddenly reduced and the gain increaser relay is operated by the gain increaser circuit.

The single figure in the accompanying drawing is a diagrammatic view of volume control circuits constructed in accordance with the invention.

Referring to the drawing voice operated gain adjusting circuits 1 are shown connected to a transmission line having input conductors 2 and 3 and output conductors 4 and 5. The voice operated gain adjusting circuits comprise a line amplifier 6, a gain decreaser circuit 7, a gain increase disabler circuit 8, a gain increaser circuit 9 and a quick gain increaser circuit 10.

The line amplifier 6 comprises two loss devices 11 and 12 and two amplifiers 13 and 14. The amplifiers 13 and 14 are preferably of the space discharge type. The loss device 11 comprises two three-element space discharge devices 15 and 16 which are effectively connected in series with the line. The loss device 12 comprises two three-element space discharge devices 17 and 18 which are effectively connected in series with the line.

The input conductors 2 and 3 are connected by a hybrid coil 20 to an input transformer 21. The secondary windings of the transformer 21 are included in the input circuits of space discharge devices 15 and 16 of the loss device 11. A transformer 22 is provided for connecting the output circuits of the space discharge devices 15 and 16 to the input circuits of the space discharge devices 17 and 18 of the loss device 12. The output circuits of the space discharge devices 17 and 18 are connected to the input circuit of the amplifier 13 by means of a transformer 23. The output circuit of the amplifier 13 is connected to the amplifier 14 by means of a transformer 24 and the output circuit of the amplifier 14 is connected by transformer 25 and the hybrid coil 26 to the output conductors 4 and 5 of the line.

A battery 27 is provided for supplying negative biasing potential to the grids of the space discharge devices 15, 16, 17, and 18 in the loss devices 11 and 12. A variable potential is impressed on the grids of the space discharge devices 15, 16, 17 and 18 in accordance with the charge on a control condenser 28. The charge on the condenser 28 is governed in the manner to be hereinafter set forth to control the variations in volume on the output conductors 4 and 5 of the line. A battery 29 is provided for supplying heating current to the filaments of the space discharge devices 15, 16, 17 and 18, a battery 30 is provided for supplying potential to the plates of the space discharge devices 15, 16, 17 and 18. The plate circuit from the battery 30 includes the coil of a gain rate relay 31. The relay 31 controls the rate at which the control condenser 28 is charged. Resistance elements 32 which are connected across the primary winding of the transformer 22 and resistance elements 33 which are connected across the primary winding of the transformer 23 are included in the plate circuits for the space discharge devices 15, 16, 17 and 18. The amplifier tubes 13 and 14 are provided with grid biasing batteries 34 and 35, and with batteries 36 and 37 for supplying plate potential.

The gain increaser circuit 9 comprises a band pass filter 38 which is connected to the hybrid coil 20, amplifier devices 39 and 40, detector 41 and a low pass filter 42. The band pass filter 38 passes currents having frequencies within the voice frequency range. A transformer 43 is provided for connecting the input circuit of the amplifier 39 to the filter 38. Transformer 44 is provided for connecting the output circuit of the amplifier 39 to the input circuit of the amplifier 40. A transformer 45 is provided for connecting the output circuit of the amplifier 40 to the input circuit of the detector 41. The amplifiers 39 and 40 and the detector 41 are preferably of the three-electrode space discharge type. The filter 42 is connected to a gain increaser relay 46. The gain increaser relay when operated completes a circuit from a battery 47 for operating a master gain relay 48. The circuit from the battery 47 for operating the master gain relay 48 includes, resistance elements 49 and a condenser 50 for effecting a hangover in the operation of the relay 48. The resistance elements 49 and the condenser 50 may be adjusted to effect any desired hangover in the operation of the relay 48. The armature of a gain increase disabler relay 51 is included in the energizing circuit for the master gain relay 48 so that whenever the relay 51 is operated it will be impossible to operate the relay 48 and effect any increase in the gain of the line amplifier 6.

The gain decreaser circuit 7 and the gain increase disabler circuit 8 are connected to a hybrid coil 52. The hybrid coil 26 connected to the line beyond the line amplifier 6 is connected by a transformer 53 to a three-element space discharge amplifier 54. The output circuit of the amplifier 54 is connected to the hybrid coil 52. The gain decreaser circuit 7 comprises a three-element detector tube 55 having the input circuit thereof connected by a potentiometer 56 to the hybrid coil 52. The output circuit of the detector tube 55 is included in a grounded circuit for effecting a discharge of the control condenser 28. If normal volume is obtained on the line beyond line amplifier 6, the tube 55 is blocked by means of the negative potential from a battery 57 to prevent any discharge of the control condenser 28.

The gain increase disabler circuit 8 comprises a gas-filled detector tube 58 of the three-element type. The input circuit of the detector tube 58 is connected to the hybrid coil 52 by means of resistance elements 59 and 60. Plate potential for

the gas-filled detector tube 58 is supplied by the battery 30. The plate circuit for the tube 58 from the battery 30 includes the operating coil of the gain increase disabler relay 51. The relay 51 when operated breaks the energizing circuit of the master gain relay 48 and prevents any charging of the control condenser 28 by means of the gain increaser circuit 9. The relay 51 when operated by the tube 58 connects a condenser 62 across the resistance element 59 in the input circuit of the tube 58. The shunting of the resistance 59 by the condenser 62 serves to increase the sensitivity of the gain increase disabler circuit.

A resistance element 63 and a condenser 64 are connected across the output circuit of the detector tube 58 in order to provide a hangover in the operation of the gain increase disabler relay 51. The condenser 64 is normally charged by the battery 30 and when the internal impedance of the gas-filled tube 58 is reduced by the operation of the gain increase disabler circuit, the condenser is discharged through the space discharge path of the tube. At the same time the gain increase disabler relay 51 is operated by current from the battery 30. After operation of the tube 58 the relay 51 is held operated by current drawn from the battery 30 for charging the condenser 64. The time of this hangover in the operation of the relay 51 may be varied by controlling the elements in the hangover circuit.

In the circuits thus far described the charge on the condenser 28 is controlled to maintain substantially constant volume on the line output conductors 4 and 5. In case the input volume on the input line conductors 2 and 3 rises somewhat above normal volume, the gain decreaser circuit operates quickly to reduce the signals to normal volume. However, if the volume of the signals on the input conductors 2 and 3 falls somewhat below normal volume, the gain increaser circuit 9 impresses a charge on the condenser 28 to control the loss devices 11 and 12 and raise the volume of the signals. However, such operation takes place after a time delay if the gain increase disabler circuit has just been operated. The time delay as heretofore set forth is effected by the hangover of the relay 51 which disables the relay 48. This time delay is required in order to retain to a large extent the characteristic variations of intensity from syllable to syllable on the speech signals.

If the peaks of the signals on the input line conductors 2 and 3 are above the peaks of a weak talker, the gain increaser circuit 9 is operated to effect operation of the gain increaser relay 46. The relay 46 completes a circuit from the battery 47 for operating the master gain relay 48. The master gain relay 48 when operated completes a circuit from battery 30 through resistance elements 66 and 67 for impressing a charge on the control condenser 28. The resistance elements 66 and 67 insure slow charging of the condenser 28. Thus the resistance elements prevent a rapid raising of the gain. The charge impressed upon the control condenser 28 opposes the negative bias from the battery 27 on the grids of the devices 15, 16, 17, and 18 to increase the gain of the line amplifier 6. The rate at which the gain on the transmission line is effected by means of the line amplifier is controlled by the gain rate relay 31. The gain rate relay 31 as heretofore set forth has the coil thereof included in the circuit of the battery 30 and the plates of the space discharge devices 15, 16, 17, and 18. The manner in which the gain is controlled by gain rate relay is disclosed and claimed in an application of S. Doba, Serial No. 608,362, filed April 30, 1932.

When the peaks of speech on the transmission line beyond the line amplifier 6 are above a predetermined upper limit the gain decreaser circuit 7 is operated to lower the charge on the condenser 28. The discharging circuit for the condenser 28 includes the space path of the detector tube 55. At this same time the gain increase disabler circuit 8 is operated to effect operation of the gain increase disabler relay 51. When the relay 51 is operated the circuit of the master gain relay 48 is broken so as to prevent any charging of the control condenser 28 from the battery 30.

The quick gain increaser circuit 10 is provided to effect a rapid charge of the condenser 28 in case the volume of signals on the line suddenly decreases a large amount. The quick gain increaser circuit comprises a three-element amplifier tube 70 having the input circuit thereof connected by transformer 71 across the line output conductors 4 and 5. The output circuit of the amplifier 70 is connected by a transformer 72 to the input circuit of a three-element gas-filled detector tube 73. A coil 74 of a polar relay 75 is included in the output circuit of the detector tube 73. Biasing batteries 76 and 77 are provided for the grids of the amplifier 70 and the detector 73 and batteries 78 and 79 are provided for impressing potential on the plates of the tubes 70 and 73. The polar relay 75 is provided with a second coil 80 which is energized by a circuit from a battery 81 which includes a coil 82 of a polar relay 83. The coil 80 of the relay 75 exerts a force tending to move the armature of the relay into engagement with a contact member 84. The coil 74 of the relay 75 when energized exerts a force in opposition to the force of the coil 80 and moves the armature of the relay away from the contact member 84.

The relay 83 is provided in addition to the coil 82 with a coil 85 which is energized from the battery 81 when the armature of relay 75 engages the contact member 84 and a coil 86 energized from the battery 47 by the armature of relay 46 when the relay 46 is deenergized. The coils 86 and 82 of the relay 83 act in opposition to the coil 85. The coil 85 exerts a force when energized tending to move the armature of the relay 83 into engagement with a contact member 87. The coils 86 and 82 exert a force stronger than the coil 85 and the coil 85 exerts a force stronger than the coil 82.

If the signals on the line are suddenly decreased a large amount, the gain increaser circuit is operated to raise the gain. The gain increaser relay 46 is operated but the relay 48 is not operated at this time because of the hangover in the operation of the relay 51. Thus, the raising of the gain is delayed according to the hangover of the relay 51. It is because of this delay in raising the volume of the signals after a sudden reduction in volume that the quick gain increaser circuit 10 is provided. The sudden reduction in volume on the line operates the quick gain increaser circuit 10 to deenergize the coil 74 and permit the coil 80 to move the relay armature into engagement with the contact member 84. When the armature of the relay 75 engages the contact member 84 the coil 85 of the relay 83 is energized from the battery 81. The armature of the relay 83 is then moved into engagement with the contact member 87 because the coil 86 is deenergized by the operation of the

relay 46. The engagement of the armature of the relay 83 with the contact member 87 completes a circuit from the battery 30 through a resistance element 90 for charging the control condenser 28 to increase the gain on the line. This effects a quick acceleration in the gain increasing action. The quick gain increasing circuit 10 is only operated upon a sudden decrease in the volume of the signal. A gradual decrease in the volume of the signals will be corrected by the normal operation of the gain increaser circuit 9.

Modifications in the system and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In a signal system, a transmission line, volume control means comprising a control device in the line and circuit means operated according to the volume of the signals on said line for maintaining the signals on said line beyond said control means at substantially constant volume and operating with a time constant to retain the characteristic variations of intensity from syllable to syllable, and means controlled by the volume of the signals on the line beyond said device for governing said control means to effect a quick acceleration thereof to raise the volume of the signals in case the volume of the signals on the line is suddenly reduced.

2. In a signal system, a transmission line, volume control means comprising a control device in the line and circuit means operated according to the volume of the signals on said line for raising and lowering the gain to maintain the signals on said line beyond said control means at substantially constant volume while retaining the characteristic variations of signal intensity from syllable to syllable, and auxiliary means connected to the line for automatically effecting a relatively quick acceleration of said control means to raise the volume of the signals when the volume of the signals supplied to the line is suddenly reduced a large amount.

3. In a signal system, a transmission line, three-element space-discharge devices effectively connected in series with said line, means for impressing a constant negative potential on the grids of said devices, a control condenser for impressing positive potential on the grids of said devices which varies directly according to the charge on the condenser, volume control means for reducing the charge on said condenser when the received signals have a volume above normal and for operating with a time constant to increase the charge on said condenser when the received signals have a volume below normal to hold the volume of the signals on the line substantially constant and auxiliary means operative upon a sudden reduction of volume on the line for effecting a quick acceleration of said volume control means to quickly raise the volume of the signals on the line.

4. In a signal system, a transmission line, volume control means comprising a control device in the line and circuit means operated according to the volume of the signals on said line for raising and lowering the gain to maintain the signals on the line beyond the control means at substantially constant volume, said volume control means normally operating with a time constant when raising the gain to retain the characteristic variations of intensity from syllable to syllable, and means automatically controlled according to the volume of the signals on the line beyond said device for accelerating the normal gain increasing action of said control means when the signal input volume to said control means is suddenly decreased a large amount.

5. In a signal system, a transmission line, volume control means comprising a control device and circuit means operated according to the volume of the signals on said line for raising and lowering the gain to maintain the signals on the line beyond the control means at substantially constant volume, said control means operating with an appreciable time constant when raising the volume of signals after a reduction in volume, and means automatically controlled according to the volume of the signals on the line beyond said control means to accelerate the gain increasing action thereof when the signal input volume to said control means is suddenly decreased a large amount.

6. In a signal system, a transmission line, volume control means connected to said line for raising and lowering the gain to maintain the signals on the line beyond the control means at substantially constant volume, said control means operating with no appreciable time constant in lowering the volume of signals of high volume and operating with an appreciable time constant in raising the volume of signals of low volume after a reduction in volume, and means automatically controlled according to the volume of the signals on the line beyond said control means for governing said control means to accelerate the gain increasing action thereof when the signal input volume to said control means is suddenly decreased a large amount.

7. In a signal system, a transmission line, three-element space discharge devices connected effectively in series with said line for controlling the volume of transmitted signals, means comprising a condenser for controlling the potential on the grids of said devices to govern said devices and maintain the volume of the signals on the line substantially constant, said means operating with an appreciable time constant in raising the volume of signals of low volume for transmission over the line after a decrease in volume, and auxiliary means automatically controlled according to the volume of the signals on the line for controlling the charge on said condenser to accelerate the gain increasing action of said devices when the signal input volume to said control means is suddenly decreased a large amount.

8. In a signal system, a transmission line, three-element space discharge devices connected effectively in series with said line for controlling the volume of transmitted signals, a condenser for controlling the potential on the grids of said devices to govern said devices, means for charging said condenser to lower the impedance of said devices when low volume signals are supplied to said line, said means operating with an appreciable time constant after a decrease in volume, and auxiliary means automatically controlled according to the volume of the signals on the line for accelerating the charging of said condenser to accelerate the gain increasing action of said devices when the signal input volume to said line is suddenly decreased a large amount.

9. In a signal system, a transmission line, impedance means on said line for controlling the volume of the signals on the line, control means for governing said impedance means to maintain

the volume of the signals on the line substantially constant, said control means operating with an appreciable time constant in raising the volume of signals of low volume for transmission over the line after a decrease in volume, and auxiliary means automatically operated according to the volume of the signals on the line for effecting a quick acceleration of said control means when the signal input volume to said line is suddenly decreased.

10. In a signal system, a transmission line, volume control means comprising a control device in the line and circuit means operated according to the volume of the signals on said line for governing the control device to maintain the signals on said line at substantially constant volume, and means automatically operated from said line for governing said control means to effect a quick acceleration in the operation thereof in case of sudden change in the volume of the received signals.

11. In a signal system, a transmission line, a three-element space discharge device connected in circuit with said line, a control condenser for impressiong potential on the grid of said device which varies directly according to the charge on the condenser, control means for quickly reducing the charge on said condenser when the received signals have a volume above normal and for increasing the charge on said condenser after a time delay when the received signals have the volume reduced below normal to hold the volume of the signals on the line substantially constant, and auxiliary means controlled from the line for effecting a quick acceleration of said control means in charging said condenser when the volume of the signals supplied to the line suddenly decreases.

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